D00012911

Purohit, Kirti

From: Rose, Jay
Sent: Wednesday, July 30, 2008 4:06 PM
To: Purohit, Kirti
Cc: Smouse, Debra
Subject: FW:another reference for ch 4

Follow Up Flag: Follow up
Flag Status: Completed

Attachments: tat chapter 4 items for roald temi todosow july 28 Reply 072808.doc

tat chapter 4 items for roald ...

Schwartz 2008 Francis Schwartz, "Chapter 4 Input from INL and ANL", Idaho National Laboratory, email to Tetra Tech July 29, 2008.

-----Original Message-----
From: schwarfg@id.doe.gov [mailto:schwarfg@id.doe.gov]
Sent: Tuesday, July 29, 2008 5:31 PM
To: Rose, Jay
Subject: Fw: issues form chapter 4 for NE and Lab experts

----- Original Message -----
From: Schwartz, Francis G
To: 'debra.smouse@tetratech.com' <debra.smouse@tetratech.com>; 'Janice.Hensley@tetratech.com' <Janice.Hensley@tetratech.com>; 'Wayne.Human@tetratech.com' <Wayne.Human@tetratech.com>
Cc: SWICHKOW, DEBORAH; Perry, Jeffrey N; Jones, Leon H
Sent: Tue Jul 29 15:28:11 2008
Subject: Fw: issues form chapter 4 for NE and Lab experts

----- Original Message -----
From: Taiwo, Temitope A. <taiwo@anl.gov>
To: Wigeland, Roald Arnold; Schwartz, Francis G
Cc: Burns, Douglas Edward
Sent: Tue Jul 29 13:24:48 2008
Subject: RE: issues form chapter 4 for NE and Lab experts

Frank and Roald,

Sorry for the delay in responding to Roald's e-mail. I was with BP all morning getting direction on the TDR. I have reviewed Roald's comments and practically agreed with them. I have included text in Bold Green Font indicating this or suggesting slight modification. Hope this is helpful.

Temi

CONFIRMED TO BE UNCLASSIFIED
DOE/OCCIR
BY: Mel Leifer (DR. ~~SO-70~~ NS-93) w/attach.
Date: 8/21/08

-----Original Message-----
From: Roald Wigeland [mailto:Roald.Wigeland@inl.gov]

MLeifer, NS-93, 8/21/08
DOES NOT CONTAIN UNCLASSIFIED CONTROLLED NUCLEAR INFORMATION

2008000 2235

Purohit, Kirti

From: Rose, Jay
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'Janice.Hensley@tetratech.com' <Janice.Hensley@tetratech.com>;
'Wayne.Human@tetratech.com' <Wayne.Human@tetratech.com>
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Sent: Tue Jul 29 15:28:11 2008
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Temi

-----Original Message-----
From: Roald Wigeland [mailto:Roald.Wigeland@inl.gov]

Sent: Tuesday, July 29, 2008 12:26 AM
To: Schwartz, Francis G
Cc: Taiwo, Temitope A.; Douglas E Burns
Subject: Re: issues form chapter 4 for NE and Lab experts

Frank,

I'm sending you a draft of my responses, which I'm also sending on to Temi so that he can do a review and add whatever he feels is necessary. Temi, please have a look at this too and let Frank know as soon as you can tomorrow.

I need to know if you think I missed something in my responses. There are some errors that need to be corrected, as I've noted.

I'll be at a meeting at BNL tomorrow, but I'll be monitoring my email.
Roald

Schwartz, Francis G wrote:

> Thanks Roald. As always, you are a lifesaver.
>
> Frank
>
> -----Original Message-----
> From: Roald Wigeland [mailto:Roald.Wigeland@inl.gov]
> Sent: Monday, July 28, 2008 1:31 PM
> To: Schwartz, Francis G
> Subject: Re: issues form chapter 4 for NE and Lab experts
>
> Frank,
>
> I've talked with Temi. We think these will be straightforward to
> address. I'll try to get these resolved today. You should have the
> responses tomorrow.
>

> Roald

> ----------

> Schwartz, Francis G wrote:

>

>> This time with attachment...

>>

>> ----------

>> --

>> *From:* Schwartz, Francis G

>> *Sent:* Monday, July 28, 2008 9:13 AM

>> *To:* Burns, Douglas Edward; Wigeland, Roald Arnold

>> *Cc:* Rose, Jay; Jones, Leon H; Perry, Jeffrey N; SWICHKOW, DEBORAH;

>> Wheeler, Jack

>> *Subject:* FW: issues form chapter 4 for NE and Lab experts

>>

>> Doug and Roald

>> We are looking for some help again based on the latest set of comments

>>

>

>

>> from GC. I am hoping this will be the last round. Jay sent this file

>> to me last Friday, but I never checked my HQ account, so am late

>> getting it to you. I added a couple of notes (in red) to two of the

>> sub-items under task 1.

>> Thanks for your help. Let me know what you anticipate for schedule to

>> respond, and if you have any questions/clarifications.

>> Frank

>>

>> ----------

>> --

>> *From:* Smouse, Debra [mailto:Debra.Smouse@tetratech.com]

>> *Sent:* Monday, July 28, 2008 8:10 AM

>> *To:* Schwartz, Francis G

>> *Subject:* FW: issues form chapter 4 for NE and Lab experts

>>

>> ---

>> --

>>

>> *From:* Rose, Jay

>> *Sent:* Friday, July 25, 2008 1:16 PM

>> *To:* Schwartz, Francis (NE-HQ); Perry, Jeffrey; joneslh@id.doe.gov

>> *Cc:* Human, Wayne; Hensley, Janice; Smouse, Debra; Smith, Mark

>> *Subject:* issues form chapter 4 for NE and Lab experts

>>

>> Hi Frank-here is a file with 5 items laying out the chapter 4

>> info/issues that we think are best suited for Roald, Temi, and Mike

>> Todosow. Let me know if you have any questions. Thx-j

>>

>>

ITEM #1: HTGR Deep Burn Alternative Issues

Per the agreement with GC, we must add quantitative data where possible, and include qualitative discussions for the other areas (even if it is a statement that we don't have enough information to speculate where this would be relative to any other alternative). Qualitative discussions should be in terms relative to other alternatives (e.g., "this alternative would generate less SNF than No action, but more than x alternative." And the per MTIHM waste and product stream quantities from the LWR separations for this deep burn alternative would be the same as under the fast reactor alternative (for the same LWR fuel burnup), etc., etc.

As such, any info that Roald and Temi can add to Section 4.5.3 would be appreciated. They should also look at the following specific items to see if they can provide resolution:

I would suggest that all of the numbers presented in Section 4.5.3 be qualified with the statements that they are only preliminary estimates, not at the same level of accuracy as for the detailed analyses used for the other alternatives, and they should not be presented in the same table as results for the other alternatives. As Section 4.5.3 text is right now, the numbers are presented in the same manner as those for the other alternatives, which is not appropriate. At this time, we have no verification that these numbers are correct, or even approximately correct, but they do represent an initial estimate that can be used to reach some general conclusions that are not sensitive to the inaccuracies associated with such estimates. **[Taiwo's Comment: Agree]**

A. Uranium Requirements: Data for the uranium requirements for the Thermal Recycle Alternative (Option 3) do not exist. [NOTE: Is the fuel for the HTGRs assumed to be an inert matrix fuel? If so, what additional information is required in order to determine uranium requirements?]

The deep burn alternative is a combination of LWRs using enriched uranium fuel and HTGRs using a TRU fuel with no uranium in the fuel, possibly using an inert matrix if needed; **currently TRU oxide is used**. The spent LWR fuel would be processed and the recovered TRU would be sent to HTGRs using the TRU fuel. There would still be uranium required to run the LWRs, which would be the same standard LWRs that we have in the no-action alternative. What we don't know accurately at this time is the proportion of LWRs to HTGRs, since we don't have detailed calculations on the performance capability of the deep burn HTGR with TRU fuel yet. Preliminary estimates indicate that the reactor fleet would have about 82% of the power being generated by the LWRs, while the other 18% would be generated by the deep-burn HTGRs.[1] Accounting for the higher thermal efficiency of the HTGRs, the thermal power would be about 88% LWR and 12% HTGR, for a reduction in uranium requirement of about 12% as compared to the no-action alternative. Even though these are only initial estimates, what can be said is that the uranium requirement for this alternative will be reduced from the no-action alternative since some of the LWRs have been replaced by HTGRs, in proportion to the percentage of HTGRs in the reactor fleet. **[Taiwo's Comment: Agree]**

[1] Presentation by Goldner, et al.

B. Fuel Fabrication Requirements: Data for the fuel fabrication requirements for the Thermal Recycle Alternative (Option 3) do not exist. [NOTE: What additional information is required in order to determine fuel fabrication requirements?]

Look at the analysis for other alternatives, see what can be said with a parallel construction. For example: Fuel fabrication would need to be a remote operation (as with the fast reactor transmutation fuel), and, while it is likely that some existing HTGR fuel fabrication process design is applicable, there are differences such as operations must be done remotely and are using fuel material. Other things that might be said are that it is not a U based fuel – inert matrix w/ TRU. no idea of loading on the fuel or fuel operating life. No U required for this fuel type (if that is what our analysis is based on). Add another sentence with design issues, etc. Discuss that, until the fuel design and physics are known, ratio of LWRs to HTGRs cannot be determined, thus don't know amount of LWR snf to be reprocessed or amount of HTGR snf requiring disposal, what the radionuclide inventory of the HTGR snf will be (thus don't know radiotoxicity, thermal load or volume associated with this HTGR snf). And since we don't know LWR ratio, we don't know the quantity of LWR snf to be reprocessed, or the volume of HLW, GTCC or LLW generated as a result of the LWR separations process.

The TRU recovered from processing all of the spent LWR fuel will be used for fabrication of the deep-burn HTGR fuel. The amount of spent LWR fuel to be processed and the amount of TRU recovered is not known accurately at this time. Given that the recovered TRU will be radioactive, the fuel fabrication will need to be done remotely, as in the other alternatives where spent LWR fuel is processed to recover the TRU for recycle. At this time, it is expected that the same fuel fabrication technologies that have been developed for enriched uranium HTGR fuel would be applicable to the deep-burn TRU fuel, although modifications may be needed for remote fuel fabrication. However, since the deep-burn TRU fuel composition has not yet been determined, the amount of deep-burn fuel fabrication can't be determined, and it is not known if additional modifications to the fuel fabrication technologies will be required, or if a new technology would be needed. **[Taiwo's Comment: Agree]**

C. Graphite wastes: Is there any information available about graphite wastes, such as how much (volume or mass) per GWe of HTGR capacity? And the classification of these wastes and how they would be disposed?

I believe Roald has developed the information for the regular HTGR alternative, but we don't know it for the deep burn since we don't know details of fuel, burnup.

As far as classification, this graphite waste would be GTCC if separated from the fuel compacts, but would be HLW if it remains with the fuel. Again, I believe Roald addressed this potential through the volume range he provided. HLW would have to go to a geologic repository, and GTCC would go to a disposal facility capable of accepting GTCC LLW waste.

The wastes for the deep-burn alternative are from several sources. For the processing of the spent LWR fuel, HLW, GTCC, and LLW will be generated, similar to that generated for the alternatives using the fast reactor recycle of TRU. Fabrication of the deep-burn HTGR fuel will generate GTCC and LLW, but there are no estimates for the amounts at this time given that there is no relevant remote fuel fabrication experience for the deep-burn HTGR fuel. After irradiation, the deep-burn HTGR fuel is sent for disposal in a geologic repository as HLW. Preliminary estimates indicate that the TRU content of the spent deep-burn HTGR fuel will be about 30% of that for the no-action alternative.[1] As a result, with such a large amount of TRU being placed in a repository, it is estimated that the reduction in decay heat load would be about a factor of 2-3 as compared to the no-action alternative. There are no estimates for the change in radiotoxicity, but given that the TRU content of the disposed spent fuel is 30% of that for the no-action alternative, there would be a corresponding reduction in radiotoxicity since radiotoxicity is controlled by the higher actinide content in the wastes. Using the metric of the radiotoxicity of the natural uranium and the reduced TRU content for the deep-burn alternative, one would expect that the radiotoxicity of the deep-burn HTGR spent fuel would drop to that of the natural uranium approximately in the time period of 50,000 – 100,000 years.

The amount of waste from processing the spent LWR fuel would be similar to that for the no-action alternative, but with the HLW, GTCC, and LLW in proportion to the lower amount of LWR generation required for the deep-burn alternative. The amount of deep-burn HTGR spent fuel is not known at this time since the fuel composition is undetermined, but the amount will be affected by the ability to separate the fuel compacts from the graphite blocks as in the HTGR-only alternative. As shown in that case, while the amount of spent fuel compacts can be relatively smaller with the HTGR fuel, if the compacts are not separated from the graphite blocks, the volume of spent fuel can be substantial. The fuel compacts are clearly HLW, while if separated, the graphite blocks may be GTCC. **[Taiwo's Comment: Agree]**

D. Accidents: The PEIS states: "The use of a transuranic fuel instead of a uranium fuel should not change the impacts of accidents, assuming design requirements of the fuel are similar." [NOTE: Provide an explanation for this conclusion.]

Tt – ask Ken Buhlman to look at this one too. I believe I remember him providing an explanation previously, and it had to do with expected performance of the particle fuel.

I would suggest that this comment be modified. The use of a TRU fuel instead of an enriched uranium fuel in the HTGR may have some impact on reactor response mainly due to the different delayed neutron fraction with the TRU fuel. However, for the spectrum of accidents typically considered for the HTGR, past experience with other reactor types has shown that the difference in delayed neutron fraction would not result in a significant difference in reactor response for accident conditions, but that the impact is more of a variation on the consequences rather than a completely different outcome. **[Taiwo's Comment: Agree]**

ITEM #2: Thorium Issue: May want to engage Mike Todosow on this one:

For Thorium SNF, we use a value of 10 MTHM/GWe. Is it possible to quantify the percentages of Thorium SNF that are UO_2 SNF and ThO_2 SNF? Also, would the distinction between UO_2 4.4% enrichment LEU SNF and UO_2 19.9% enrichment LEU SNF be relevant to any differences in impacts that we should disclose (i.e., would the 19.9% SNF have higher thermal loading and radiotoxicity? Would it be managed differently, and if so, how?).

For this alternative, there are two fuel types, one is uranium oxide only with an enrichment of 19.9% U-235, the other is a mixture of uranium oxide enriched to 12.2% U-235 and natural thorium oxide. Thorium oxide does not exist by itself as a fuel. The reason this is done is to ensure that the U-233 that is created from Th-232 in the thorium oxide is diluted with sufficient U-238 from the uranium oxide fuel so that the uranium in the thorium oxide / uranium oxide fuel pins remains as LEU. Within the thorium oxide / uranium oxide fuel, there is 13% uranium and 87% thorium for the heavy metal content.

The thorium/uranium fuel has a discharge burnup of 75 GWd/MTIHM. The uranium fuel has a discharge burnup of 149 GWd/MTIHM. The thorium/uranium fuel is in the reactor for 6-9 18 month cycles, while the uranium fuel is in the reactor for three 18 month cycles. The measure of so much MT SNF per GWe-yr of power production would go something like this:
For the PWR, 51 GWd/MTIHM would have generated 16.83 GWe-d/MTIHM at 33% thermal efficiency or 0.046 GWe-yr/MTIHM, invert to get 21.7 MTIHM/GWe-yr, which is what we have.
Now for the thorium alternative, 149 GWd/MTIHM burnup on the uranium seed fuel would have generated 49.2 GWe-d/MTIHM at 33% thermal efficiency, or 0.135 GWe-yr/MTIHM, invert to get 7.4 MTIHM UOX SNF/GWe-yr. The 75 GWd/MTIHM ThOX/UOX fuel would have generated 24.75 GWe-d/MTIHM or 0.068 GWe-yr/MTIHM, or invert to get 14.74 MTIHM ThOX/UOX SNF/GWe-yr.
For transport, when it **is** time to ship the spent fuel, assuming we shipped 1025 MTIHM SNF/yr, we would be transporting 410 MTIHM/yr of UOX SNF at 7.4 MTIHM/GWe-yr, and 615 MTIHM/yr of ThOX/UOX SNF at 14.74 MTIHM/GWe-yr.

The reduction in thermal load has already been provided, calculated as estimated from the integrated decay heat, as described in the reference report. The radiotoxicity curve has also already been provided, and is presented in the reference report. Both of these reflect whatever the effects are from the higher initial uranium enrichments. With lower decay heat and lower initial radiotoxicity, there is no reason why the spent fuel would have to be handled in a different manner from the LWR spent fuel. From what I can tell, all of the information that is needed to describe the impacts has already been provided in detail.
[Taiwo's Comment: Agree]

ITEM #3:R&D NEEDS

In Table 4.8.1-1, we need to check each of the yes/no answers as compared to the narrative – there is currently some inconsistency between the table and the text. Is there

some way to qualitatively assess how much is required (i.e. low, medium, high or use a "Consumer Reports" method)

I don't have much to suggest here. I think there are references that one can use to show where experience is sufficient to state that no significant research is needed. In the same way, it is apparent where research is needed. However, as much as I would like to be able to further qualify the amount of research needed, I don't think one can qualify it further since if research is needed, it is difficult to tell ahead of time how much research may be needed to reach the desired goal. For example, on the fast reactor, there needs to be development of the TRU fuel, but I don't think anyone can say how much. Fuel performance is also uncertain, and I don't think there is any way to be more precise about how large the uncertainty may be. Sodium-cooled fast reactors have been built in the past, so there really is no 'research' needed to build one. However, the industrial infrastructure to manufacture everything needed probably doesn't exist in the U.S. Successful development of appropriate waste forms and containers also needs to be developed, but again, it would be difficult to further qualify that assessment. I think the same thing can be said throughout the table. **[Taiwo's Comment: Agree. It would be a major effort to quantify the R&D needs for these alternatives.]**

TABLE 4.8.1-1—*Comparison of the Research and Development Needs of the Domestic Programmatic Alternatives* [Better indicate the relative amount of effort required. Rather than yes/no, use a relative ranking for the "yes" boxes.]

	Uranium Enrichment	Fuel Development and Fabrication	Fuel Performance	Reactor	Spent Fuel Processing	Waste Disposal
No Action	No	No	No	No	Not Applicable	SNF – No
Fast Recycle	No	Yes	Yes	No [NOTE: Verify.]	Yes	HLW – Yes
Thermal/Fast Recycle	No	Yes	Yes	No	Yes	HLW – Yes
Thermal Recycle (Option 1)	No	Yes	Yes	No	Yes	HLW – Yes
Thermal Recycle (Option 2)	No	Yes	Yes	No	Yes	HLW- Yes SNF- No
Thermal Recycle (Option 3)	No	Yes	Yes	Yes	Yes	HLW- Yes SNF- No
Thorium	No	Yes	Yes	Yes	Not Applicable	SNF – No
HWR/HTGR (Option 1—HWR)	No	No	No	No	Not Applicable	SNF – No
HWR/HTGR (Option 2—HTGR)	No	Yes	Yes	Yes	Not Applicable	SNF – No

ITEM #4: Footnotes for Table 4.8-1:

a 200 GWe is the power production, not the installed capacity. Reactor capacity factors (i.e., the percentage of time that the reactor is producing power) less than 100 percent means that the installed capacity of the reactors must be greater than 200 GWe. Typical values are 90 percent or higher for LWRs and 80 to 85 percent for fast reactors.

b Mass listed is only for the remaining heavy metal and the fission products in the SNF; no hardware or cladding is included. [Where are hardware/cladding addressed? Add a footnote or something to an existing footnote that tells where the hardware/cladding are included (we say where it isn't, but not where it is)]

The fuel cladding and assembly hardware are included in the waste volume estimates for HLW and GTCC further down in the Table, as appropriate.

c The lower value represents the volume of the fuel compacts after separation from the graphite hexagonal prismatic blocks; the higher value represents the volume of spent fuel assuming that the fuel compacts are still in the graphite hexagonal prismatic blocks. [Plain language, please.]

Unfortunately this is plain language for the prismatic HTGR fuel. I can't think of a simpler way to express this while still maintaining technical accuracy.

d Lower values represent the "lower bound" (LB) estimates of waste by considering waste from the spent fuel only, with no consideration of wastes from operations, maintenance, etc. The LB estimate considers potential volume reductions associated with advanced waste forms, decay storage to reduce hazard, and potential classification and disposal requirements based on hazard instead of origin. Upper values represent the "upper bound" (UB) and are estimated using projections based on existing technologies and operating experience, with no allowance for advanced waste management approaches like decay storage of wastes with shorter-lived hazards prior to disposal. PEIS analysis is based on UB values. [Is storage for decay prior to disposal really an "advanced waste management" approach? Isn't it a common practice?] [This may need a more complete explanation in the text. It appears to be significant information affecting the comparison of alternatives. Footnote implies that certain waste estimates could increase if, for example, waste classification moved a material from HLW to LLW.] [NOTE: Verify that this footnote applies to entry for last row, Thermal Recycle (Option 2).]

Decay storage of specific waste forms containing short-lived fission products is not currently done at this time. With advanced processing, one may choose to use such extended storage options for certain waste forms if there is significant waste management advantage, such as eliminating a radiological hazard before disposal, but it is not a common practice, or even a practice at all at this time. If such an option is available for an alternative, it is used consistently for each alternative. If it is not technically available with an alternative, then it can't be considered. The footnote is not intended to imply that waste estimates will increase if waste classification was changed. What it does say is that the lower bound estimate may be different if waste reclassification is not considered.

e HLW production is estimated at 300 m3/yr for 100 GWe-yr per year; however, this value includes HLW from operating the processing plant, and represents more than just the materials originating in the fuel. As such, this value is not compatible with the HLW values listed for the other alternatives that only consider HLW originating with the spent fuel. Some material that would be classified as HLW in the United States would result in another 482 m3, so the total is conservatively estimated at 789 m3, rounded to a range of 300-800 m3/yr for 100 GWe-yr/yr. LLW waste generation is estimated at 5,180 m3/yr. Since it is not known whether this represents an upper or lower bound, or represents an expectation based on recent results, this value is not listed in the Table. Although no radiotoxicity data were available for the DUPIC approach, given that all of the fission products and actinides would be sent to the repository as with the current once-through approach, it is likely that the time required for the radiotoxicity of the disposed spent HWR fuel from DUPIC to decrease to that of natural uranium ore to be similar as well, i.e., on the order of 100,000 – 300,000 years. [This may need a more complete explanation in the text. It appears to be significant information affecting the comparison of alternatives.] [NOTE: Last sentence appears to warrant a separate footnote.]

The information in the footnote could also be explained in the text without a problem, I would think. The footnote is intended to address all of the issues for the DUPIC case, rather than having multiple footnotes dealing with each issue with DUPIC where the data is not available.

ITEM #5: Section 4.8.7 Issues related to "Sensitivity of Analysis to Assumptions Related to Separations and Recovery Efficiency":

Sensitivity of Analysis to Assumptions Related to Separations and Recovery Efficiency. In this PEIS analysis, the assumption has been made that for cases where SNF is recycled, the loss of desired materials into the waste streams is 0.1 percent. The losses can occur in a separations plant or during fuel fabrication. The sensitivity of the waste management metrics to a higher loss rate was evaluated (see Wigeland 2008b for details on this evaluation). A summary of that analysis is as follows:

a. The volume of HLW is dominated by the fission products. The addition of a small amount of plutonium, such as would occur if the loss rate were 1 percent instead of 0.1 percent, would make little difference. This would also be true for GTCC LLW, as this is dominated by the cladding and assembly hardware from the SNF, along with other wastes from processing and operations. If the loss of transuranics were to waste streams that would be designated LLW, such loss could increase the volume or activity of LLW, or both, and could also increase the volume of GTCC LLW, because in order for wastes to be LLW, they would need to have very low concentrations of alpha radiation emitters, including plutonium (10 CFR 61.55), or the loss would result in the waste being reclassified as GTCC LLW. [NOTE: Would higher process losses (a) slightly increase the volume of LLW, but also (b) increase the activity level of a given volume of waste, which would have the potential to decrease the volume of LLW and increase the volume of GTCC LLW due to the change activity levels?]

Deleted: plutonium

I don't think we can say if the volume of LLW would increase or if the activity of the same amount of LLW would be higher if we had higher process losses. It could be one or the other, or a combination of both. I think this section is probably correct in that the increase in GTCC would be small compared to the large GTCC already present from the cladding and hardware. I've made some suggestions in the text. **[Taiwo's Comment: Agree]**

b. The thermal load reduction factor would be relatively unaffected because all of the americium and curium, the major heat producing transuranics, would already be in the HLW. Thus, an increase in plutonium loss from 0.1 to 1.0 percent would have essentially no impact on thermal load.

Comment [Roald1]: This statement is not correct.

If this statement were true, it would only be applicable for the Thermal Recycle Option 1. It should be qualified in that manner. However, I don't think this statement is correct, since additional plutonium loss will increase the decay heat and have a negative impact on the thermal load. The same is true for those cases dealing with TRU. This summary is not correct. **[Taiwo's Comment: Agree]**

c. Higher losses to the HLW would significantly affect the radiotoxicity, since the reduction in radiotoxicity is mainly due to the much lower transuranic content. It can be estimated that if the loss of transuranics to the HLW were 1.0 percent instead of 0.1 percent, the increased radiotoxicity would delay the time at which the waste would decay to natural uranium ore (Wigeland 2008b). [NOTE: Any quantification of the range of potential impacts on the time period? Also, item c refers to transuranics, whereas items a and b refer to plutonium. Do the "desired materials" subject to process losses vary by alternative? If so, this point should be addressed in the text. In any event, however, the comparisons should be consistent.]

The transuranics are responsible for the radiotoxicity for the entire time that the waste is in the repository (fission products are mainly important prior to **and in early stages of** disposal). In those cases where the losses only refer to a subset of the transuranics, then the same comments still apply. For example, if only

plutonium were recovered, an increase in plutonium loss to the waste would increase the radiotoxicity of the waste, in the same manner as if TRU was being recovered. **[Taiwo's Comment: Agree]**

NOTES for Roald to consider in answering these questions and revising text:

Process losses from separations would be expected to primarily end up in the HLW stream or GTCC (for spent equipment, job control). Process losses from fuel fab would be expected to end up primarily in GTCC or LLW (depending on contamination type and activity).
This statement is not correct. Process losses in separations end up in all 3 waste classes. Process losses from fuel fab can only end up in GTCC or LLW, since I don't think there is any way to have them be HLW. **[Taiwo's Comment: Agree]**

Include the above concept in the text in the paragraph in question. Also need to address the fact that changes in activity could move a waste from one category to another for GTCC and LLW.

Change references to "plutonium" to "transuranics" except one case in a. and in b. where plutonium is accurate ("including plutonium" in a., and the entire item b are ok). Define what is meant by "desired materials" and that they are different from alternative to alternative (the current section seems to be written based on thermal option 1 or thermal/fast and NOT using advanced separations). If possible, provide some description of what these process losses might mean in terms of radiotoxicity or heat load. This may be done qualitatively using the graphs, like figure 4.8-5)
This section needs to be redone. Section b. is incorrect and needs to be rewritten to address heat load. Transuranics should be used everywhere, since Pu is a transuranic. I think comment c. already addresses the effects on radiotoxicity. **[Taiwo's Comment: Agree]**